Climate Change & Human Health: Local and National Perspective

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Maryland Climate Coalition

Climate Stewards of Greater Annapolis

UNIVERSITY OF MARYLAND 18 56
SCHOOL OF PUBLIC HEALTH

MARYLAND INSTITUTE FOR APPLIED ENVIRONMENTAL HEALTH
MIAEH

Outline

- **BACKGROUND**
  - Our changing climate
    - Extreme events
    - Alteration in plant phenology
- **LOCAL PERSPECTIVES**
  - Extreme events and Adverse Health in MD
    - Respiratory disease: Asthma
    - Cardiovascular disease: Myocardial Infarction
    - Foodborne disease: Salmonellosis
- **NATIONAL PERSPECTIVES**
  - Changes in plant phenology and allergic rhinitis
- **QUESTIONS/DISCUSSION**

Definition

Weather:

- State of atmosphere at a given place and time
  - *Temperature, precipitation, wind speed/direction etc.*

Climate:

- Aggregated pattern of weather averages, extremes, timing, spatial distribution) of…
  - *hot & cold; cloudy & clear; humid & dry; drizzles & downpours; snowfall, snowpack, & snowmelt; blizzards, tornadoes, & typhoons*

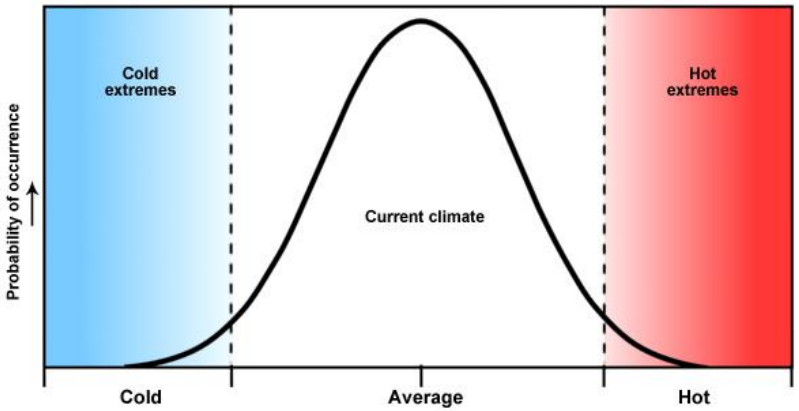
Climate Change:

- Altered patterns of Climate
- Deviation from the long term averages
  - *Global average temperature is just one measure of the state of the global climate, but perhaps the only measure that is talked about.*

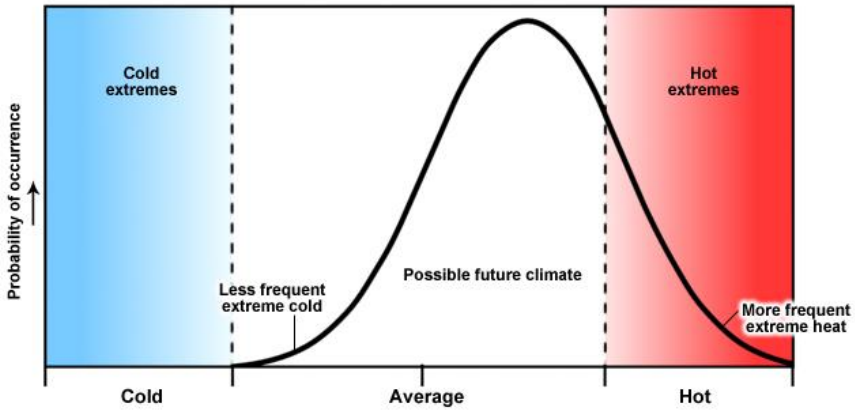
Challenge

- Climate Change: Decadal time scale
  - Most epidemiological studies last only few years.
  - How do you link health effect with something that happens in decadal scale?
- Metric we use to measure exposure:
  - Concentration
  - Duration
  - Frequency

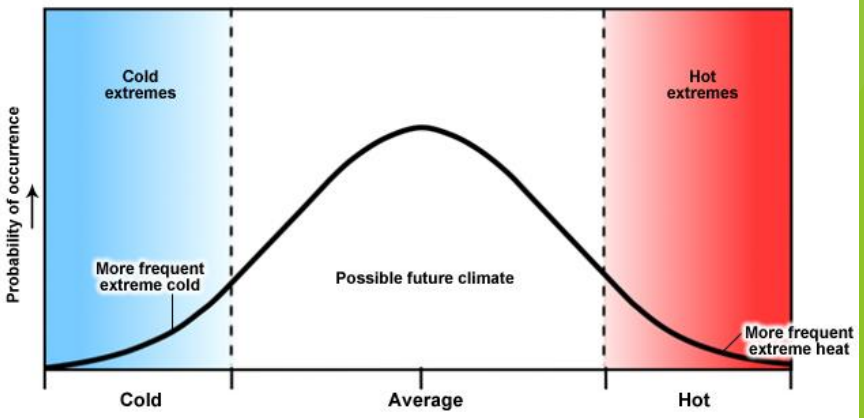
Extreme Temperatures



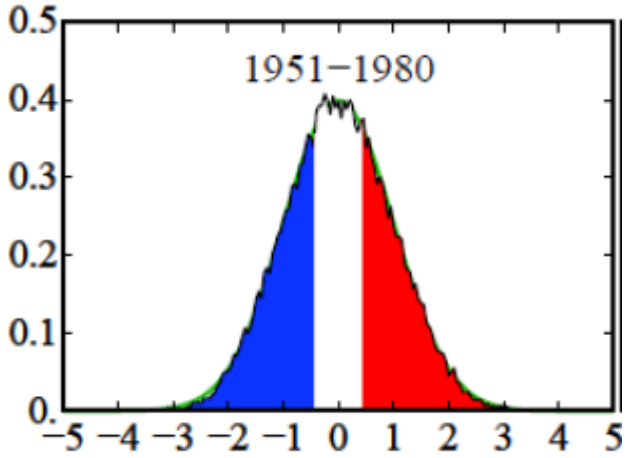
Rise in average temperature



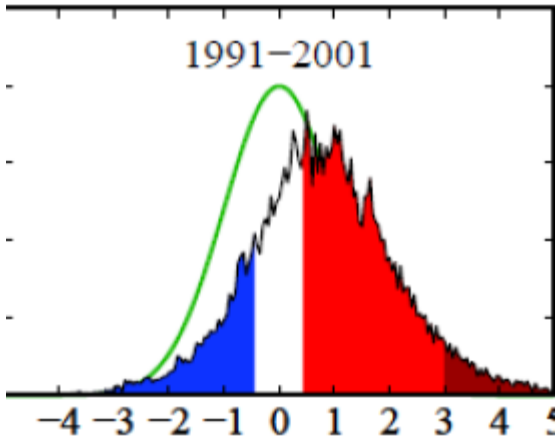
Average temperature remains the same, but number of extremes events rise



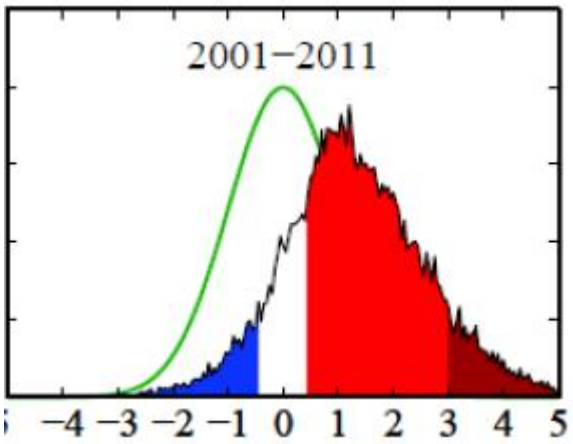
COMET program



Occurrence of summertime temperature anomalies over land, relative to 1951-1980, in the unit of Standard Deviation



1991-2001



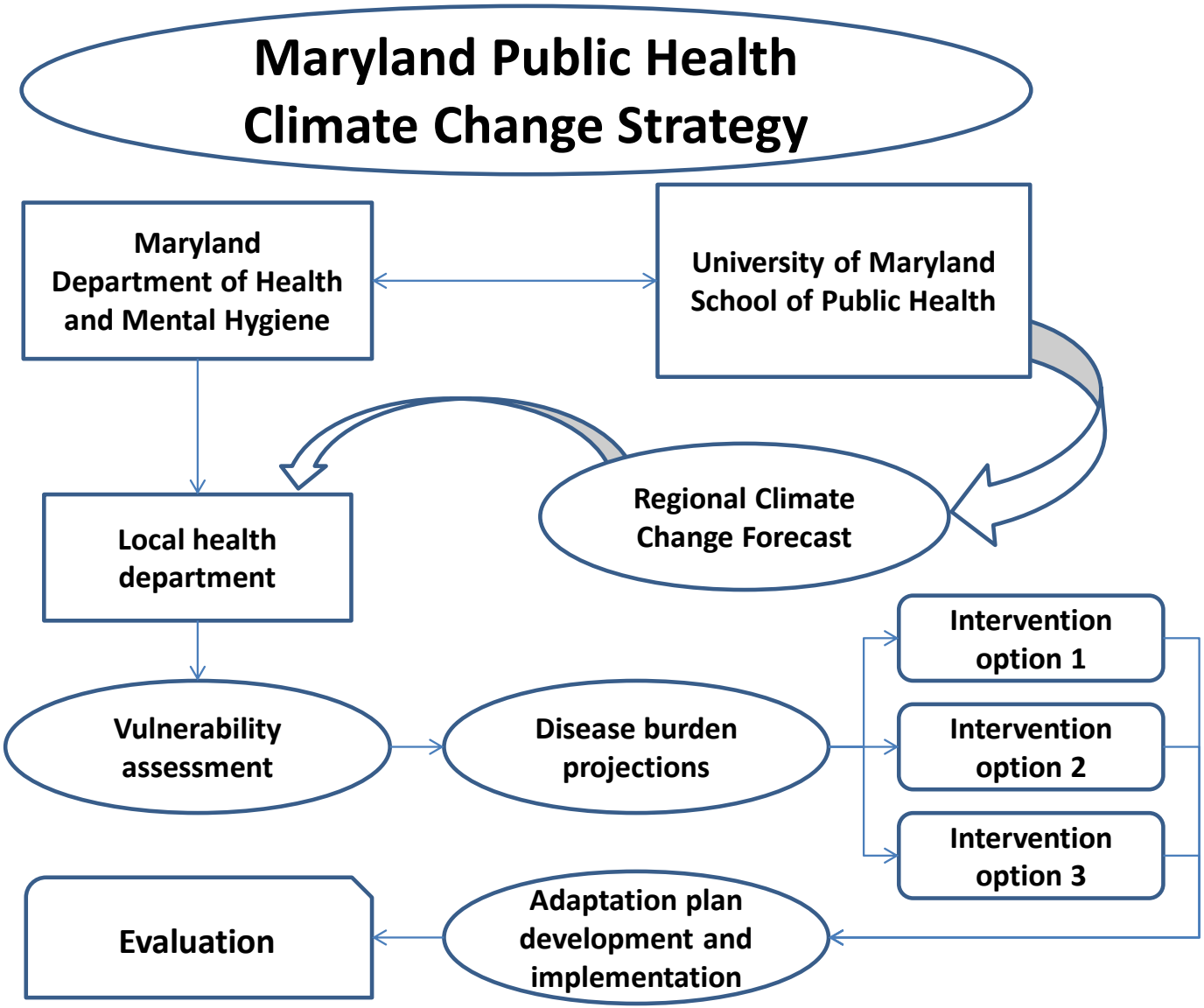
2001-2011

Looking into the Future…

- In response to our changing climate, extreme events will become:
  - More frequent
  - More intense
  - Longer lasting

  (Field et al. 2012)

- Question: How such extreme events will impact **Human Health**?


Maryland Public Health Climate Change Strategy
Maryland Department of Health and Mental Hygiene
University of Maryland School of Public Health
Regional Climate Change Forecast
Local health department
Vulnerability assessment
Disease burden projections
Intervention option 1
Intervention option 2
Intervention option 3
Adaptation plan development and implementation
Evaluation

Vulnerability Assessment

- 4 jurisdictions
  - Baltimore City
  - Prince George's County
  - Washington County
  - Wicomico County
- Health outcomes being analyzed
  - Asthma
  - Myocardial Infarction
  - Salmonellosis,
  - Campylobacteriosis,
  - Injuries

Background: Asthma

- Chronic lung disease that inflames and narrows the airways, making breathing difficult
- Over 25 million Americans are currently living with asthma (2010).
- It costs US economy over $56 billion/year

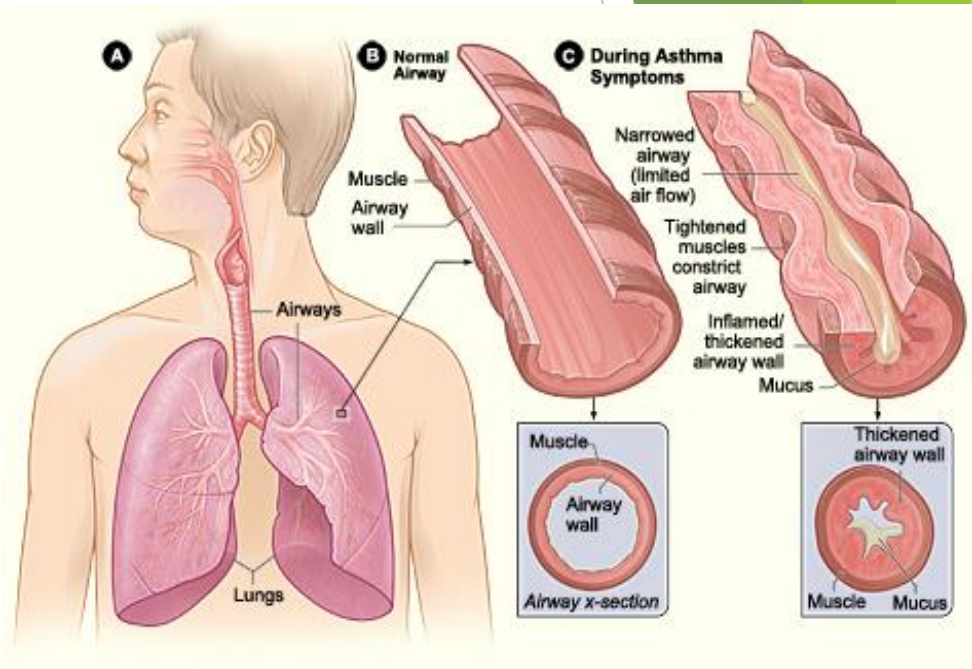
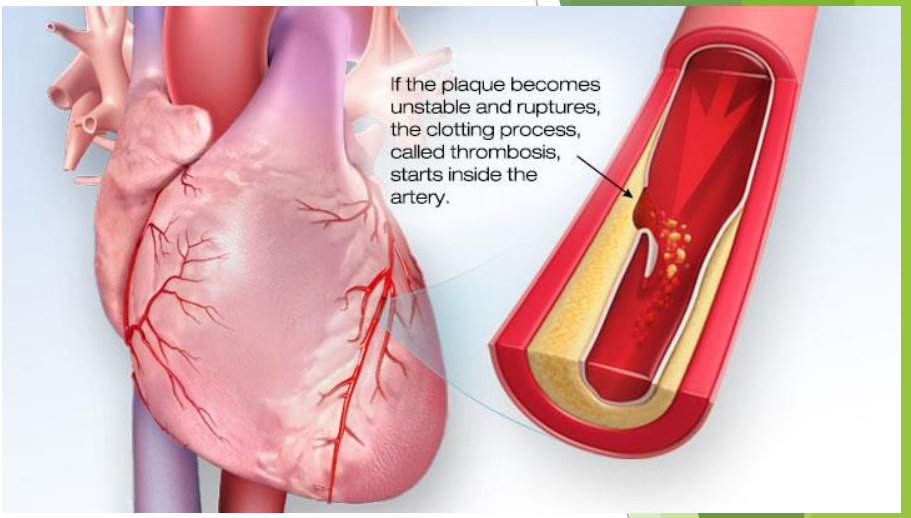


Figure: NHLBI , nhlbi.nih.gov/health/health-topics/topics/asthma

Background: Acute Myocardial Infarction

- Commonly called Heart Attack
- Occurs when blood flow that supplies oxygen to heart muscle is severely reduced/stopped.
- Over 700,000 Americans suffer from AMI every year.



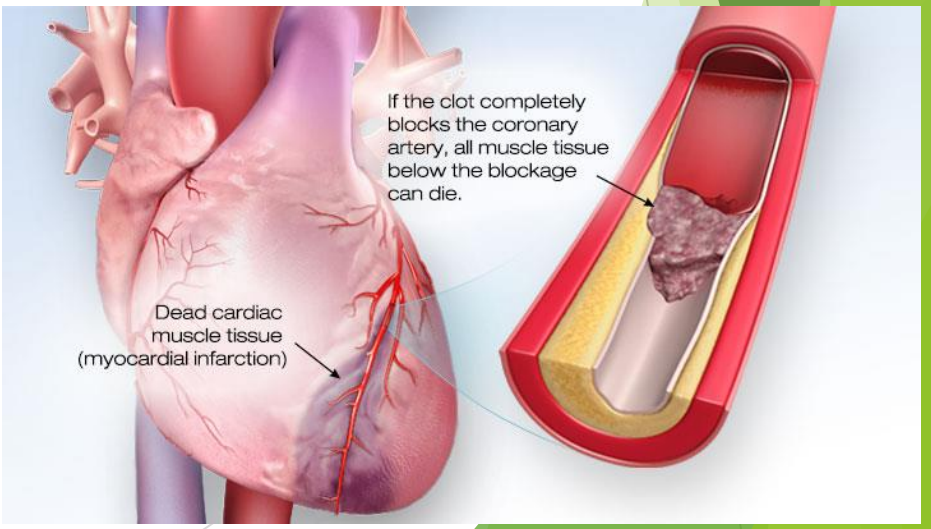
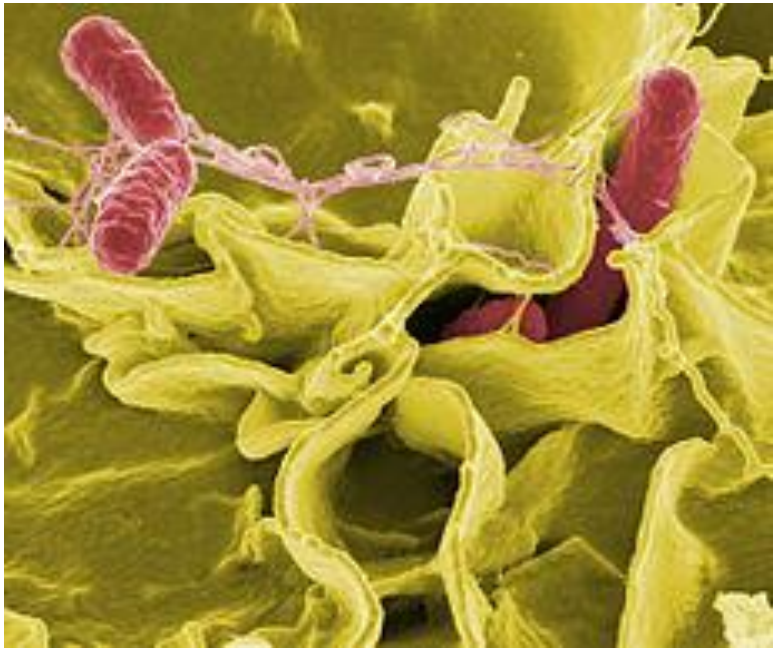


Image: American Heart Association

Background: *Salmonella* Infection



- Causes an estimated 1.2 million cases of acute gastroenteritis, including 23,000 hospitalizations.
- Infected people develop diarrhea, fever, and abdominal cramps, lasting 4-7 days.
- Many kinds, but *Salmonella* Typhimurium and *Salmonella* Enteritidis are the most common.
- More common during warm season.

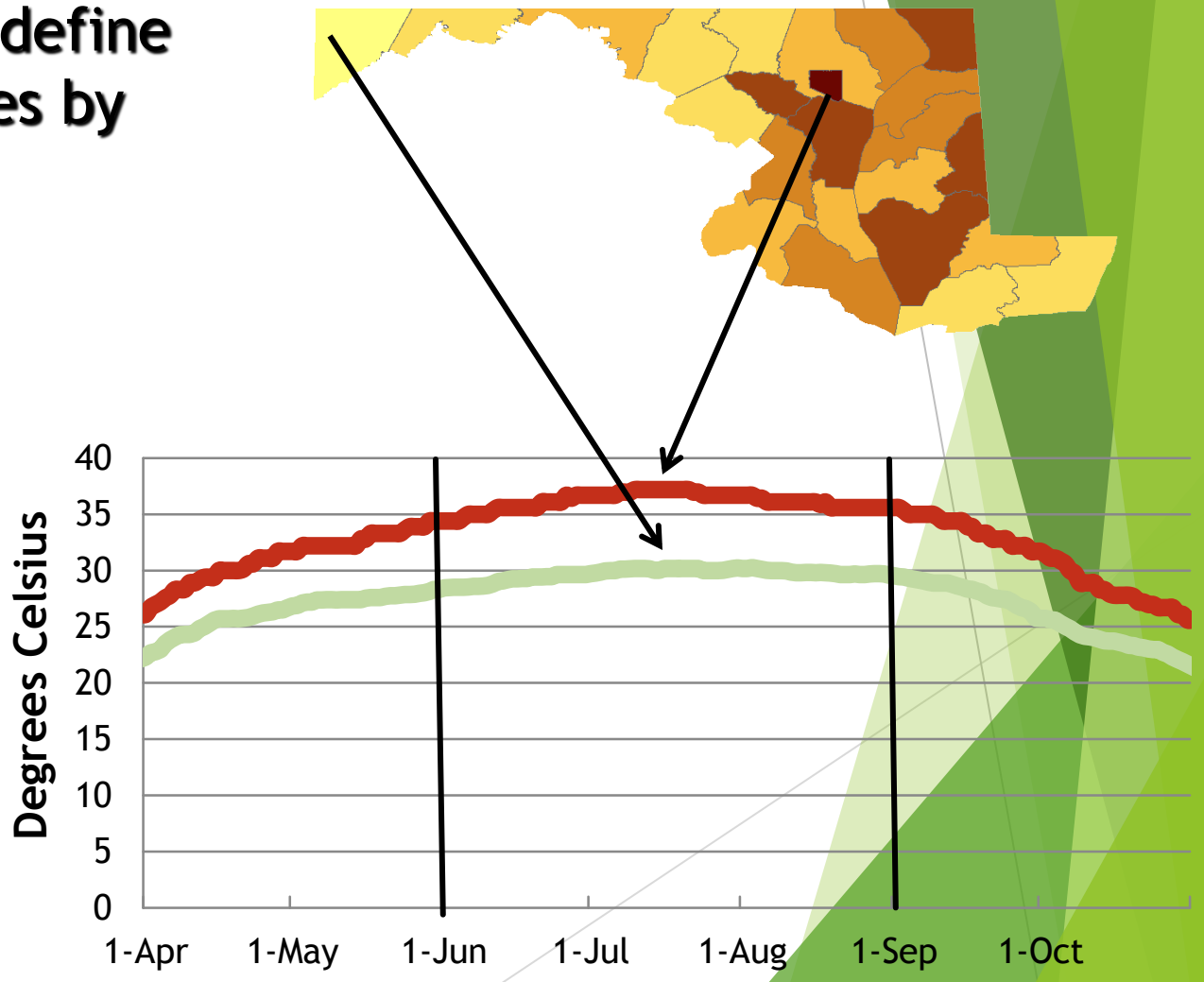
Demographic Characteristics of Health Data (2000-2012)

CHARACTERISTICS	Asthma Hospitalization		Heart Attack Hospitalization		Salmonellosis	
	# of Cases	% of Cases	# of Cases	% of Cases	# of Cases	% of Cases
Total	115,923	100	138,665	100	9,529	100
Age Group						
Under 5	18,043	16	58,036	42	2,380	25
5 to 17	16,649	14	80,629	58	1,661	17
18 to 64	59,462	51			4,462	47
65 and older	21,768	19			979	10
Gender						
Female	70,695	61	59,849	43	5,023	53
Male	45,226	39	78,812	57	4,475	47
Race/Ethnicity						
Non-Hispanic White	47,151	41	95,555	69	3755	39
Non-Hispanic Black	58,347	50	28,293	20	2,509	26
Hispanic	3,047	3	1,632	1	515	5
Other	3,479	3	5,987	4	293	3
Unreported	3,899	3	7,198	5	2,457	26
Season						
Winter	30,436	26	36,511	26	1,377	15
Spring	31,103	27	35,460	25	1,853	19
Summer	20,776	18	32,670	24	3,777	40
Fall	33,608	29	34,024	25	2,520	26

Extreme Heat Events in MD

- Threshold used to define extreme heat varies by county and by day

Example: ETT95 values on July 15th
(Range: 30-36 C)



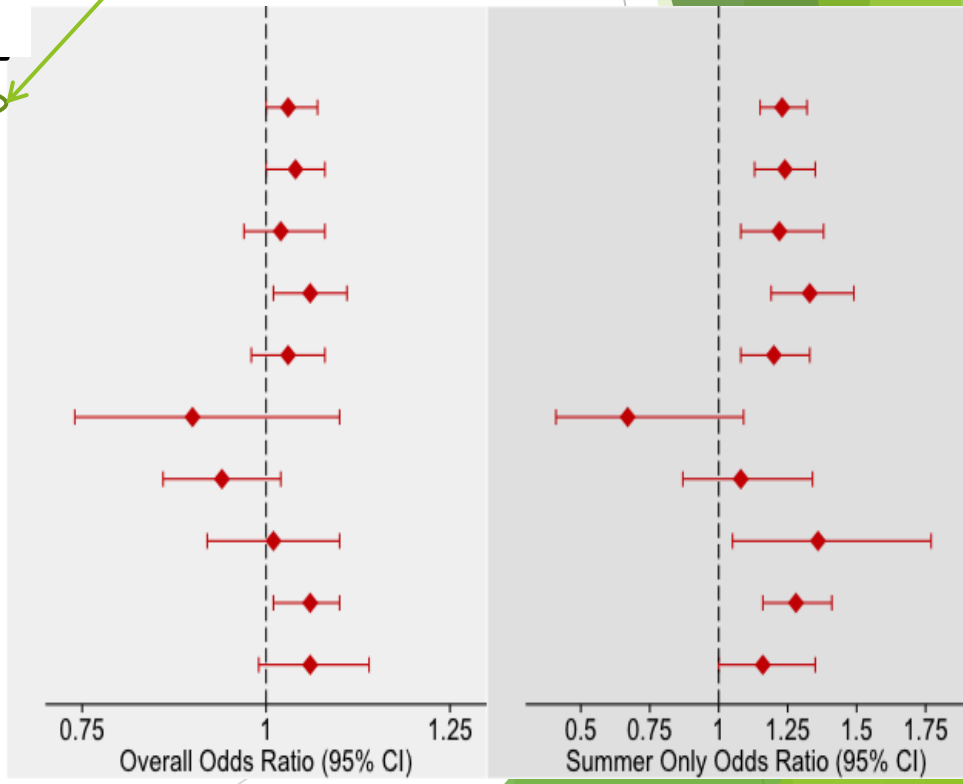
Summary of Methods

- Link Extreme event data and Health data
- Perform statistical Analysis
  - Shows if extreme events are related to disease risk
  - If yes, how much.
- Estimate Extreme event in the future from climate projections
- Estimate disease burden in the future.

Extreme Heat Events and Risk of ER Visit for Asthma

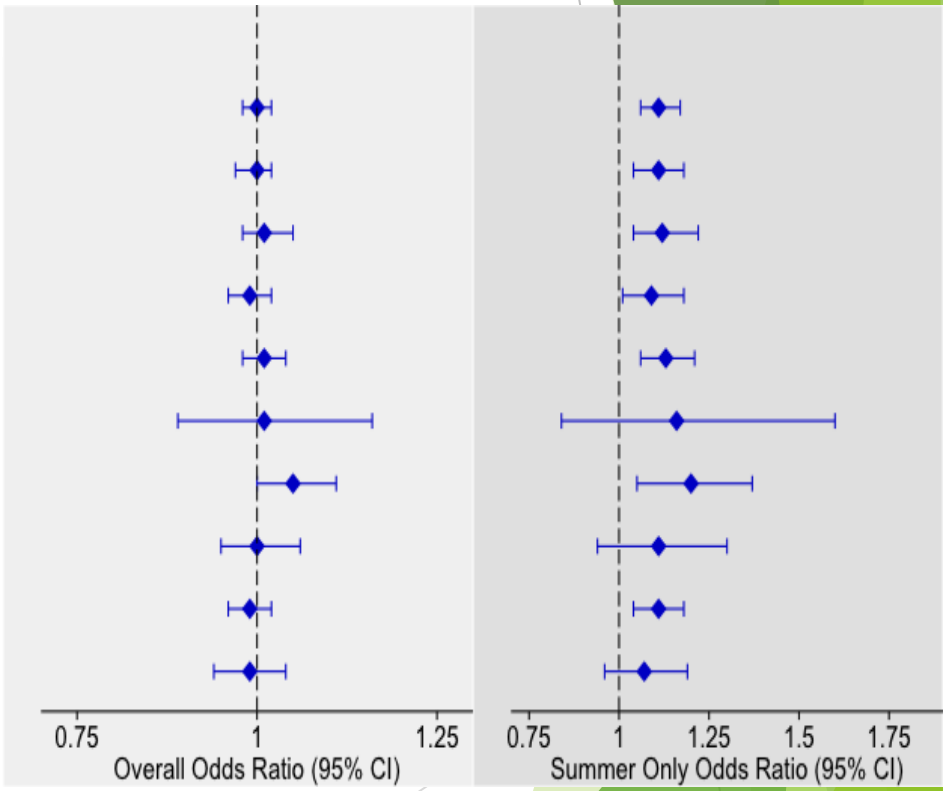
Related to 1 day increase in extreme heat event

Characteristics	Subgroups	Overall OR (95%CI	Summer Only OR (95%CI)
All	All of Maryland	1.03 (1.00, 1.07)	1.23 (1.15, 1.32)
Gender	Female	1.04 (1.00, 1.08)	1.24 (1.13, 1.35)
	Male	1.02 (0.97, 1.08)	1.22 (1.08, 1.38)
Race/Ethnicity	White	1.06 (1.01, 1.11)	1.33 (1.19, 1.49)
	Black	1.03 (0.98, 1.08)	1.20 (1.08, 1.33)
	Hispanic	0.90 (0.74, 1.10)	0.67 (0.41, 1.09)
Age Group	0 to 4	0.94 (0.86, 1.02)	1.08 (0.87, 1.34)
	5 to 17	1.01 (0.92, 1.10)	1.36 (1.05, 1.77)
	18 to 64	1.06 (1.01, 1.10)	1.28 (1.16, 1.41)
	65 and over	1.06 (0.99, 1.14)	1.16 (1.00, 1.35)



Extreme Precipitation Events and Risk of ER Visit for Asthma

Characteristics	Subgroups	Overall OR (95%CI)	Summer Only OR (95%CI)
All	All of Maryland	1.00 (0.98, 1.02)	1.11 (1.06, 1.17)
Gender	Female	1.00 (0.97, 1.02)	1.11 (1.04, 1.18)
	Male	1.01 (0.98, 1.05)	1.12 (1.04, 1.22)
Race/Ethnicity	White	0.99 (0.96, 1.02)	1.09 (1.01, 1.18)
	Black	1.01 (0.98, 1.04)	1.13 (1.06, 1.21)
	Hispanic	1.01 (0.89, 1.16)	1.16 (0.84, 1.60)
Age Group	0 to 4	1.05 (1.00, 1.11)	1.20 (1.05, 1.37)
	5 to 17	1.00 (0.95, 1.06)	1.11 (0.94, 1.30)
	18 to 64	0.99 (0.96, 1.02)	1.11 (1.04, 1.18)
	65 and over	0.99 (0.94, 1.04)	1.07 (0.96, 1.19)



Differences in Risk of Hospitalization for Asthma Related to Extreme Heat Event

County/State	Season	OR (95% Confidence Interval)
Maryland	Summer	1.22 (1.15 – 1.33)
Baltimore City	Summer	1.36 (1.14 – 1.64)
Prince George's County	Summer	1.20 (1.01 – 1.41)
Washington County	Summer	1.76 (1.09 – 2.84)
Wicomico County	Summer	1.22 (0.77 – 1.94)

Extreme Heat Event and Heart Attack in Maryland

Exposure to Extreme Heat Event and Risk of Hospitalization for Heart Attack (2000-2012)

Characteristic	Cases	Extreme Heat Event OR and 95% CI
Overall Model	32,670	1.11 (1.05 – 1.17)
Gender		
Male	18,722	1.12 (1.05 – 1.21)
Female	13,948	1.09 (1.00 – 1.19)
Age		
Age 18-64	14,067	1.10 (1.02 – 1.20)
Age >=65	18,603	1.11 (1.04 – 1.20)
Race		
Non-Hispanic White	22,343	1.09 (1.02 – 1.16)
Non-Hispanic Black	6,730	1.27 (1.12 – 1.44)

Analysis restricted to summer months only

Exposure to Extreme Heat Event and Risk of Hospitalization for Heart Attack (2000-2012)

Characteristic	Cases	Extreme Heat Event OR and 95% CI
Non-Hispanic White		
Age 18-64	8,697	1.01 (0.91 – 1.13)
Age 65+	13,646	1.14 (1.05 – 1.24)
Non-Hispanic Black		
Age 18-64	3,616	1.37 (1.16 – 1.62)
Age 65+	3,113	1.16 (0.96 – 1.40)
Male		
Age 18-64	9,734	1.14 (1.04 – 1.26)
Age 65+	8,988	1.10 (0.99 – 1.22)
Female		
Age 18-64	4,333	1.02 (0.87 – 1.19)
Age 65+	9,615	1.13 (1.02 – 1.24)

Analysis restricted to summer months only

Differences in Risk of Hospitalization for Heart Attack Related to Extreme Heat Across Counties

County/State	Summer Only Odds Ratio 95% CI)
Maryland	**1.11 (1.05, 1.17)**
Baltimore City	**1.43 (1.16, 1.75)**
Prince George's County	1.06 (0.91, 1.24)
Wicomico County	1.00 (0.74, 1.35)
Washington County	0.96 (0.71, 1.29)

Extreme Event and Salmonellosis in Maryland

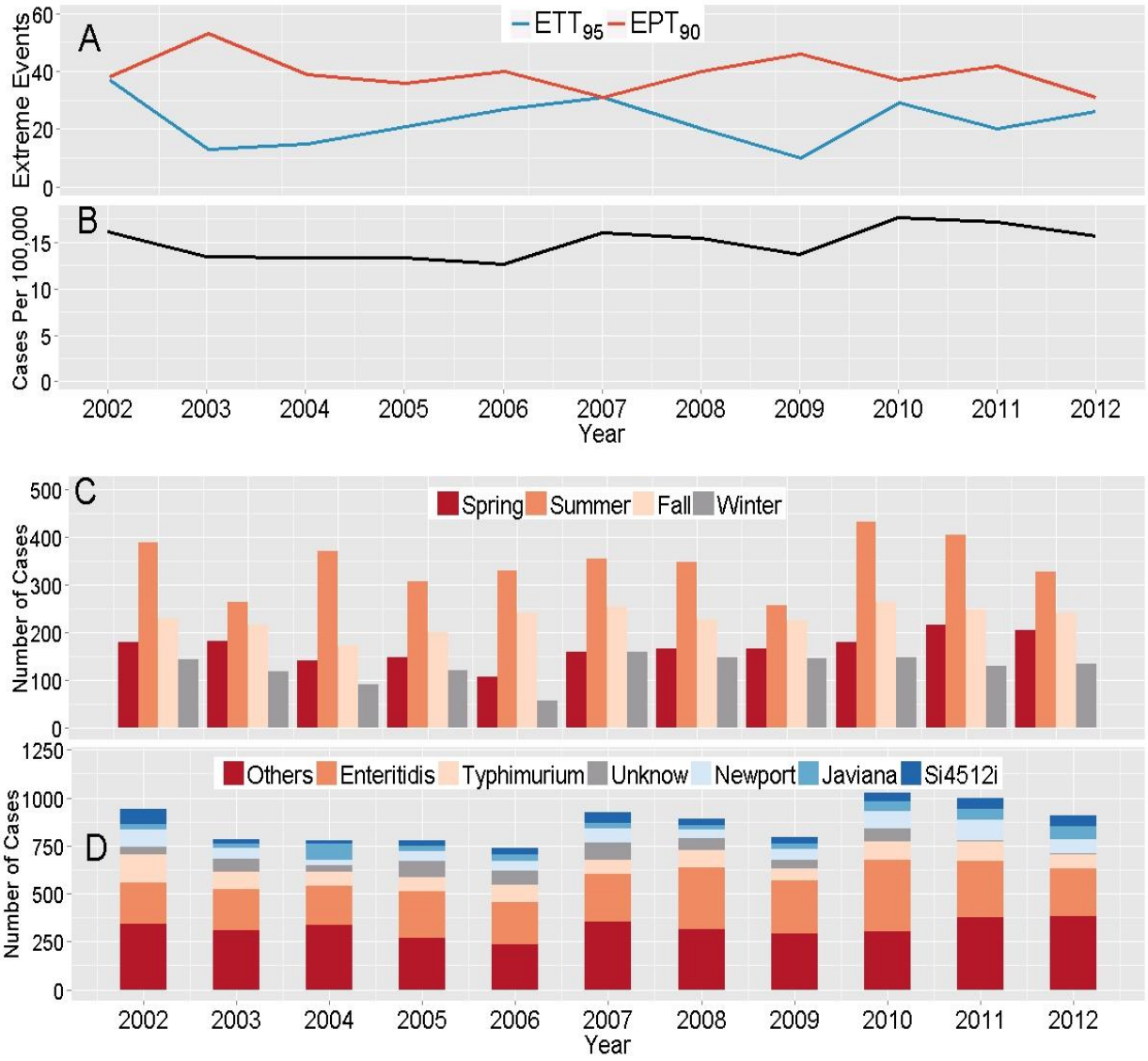
Salmonellosis: Temporal Trends

Extreme Temperature & Precipitation

Incidence Rate

Cases by Season

Cases by Serotype



Extreme Events and Salmonellosis

Characteristics	Extreme Temp. (ETT_{95})	Extreme Precip. (EPT_{90})
Overall Model	1.041[1.013-1.069]	1.056[1.035-1.078]
Season		
Spring	0.961[0.926-0.997]	1.013[0.984-1.042]
Summer	1.045[1.014-1.077]	1.017[0.989-1.046]
Fall	1.004[0.964-1.045]	1.037[1.015-1.060]
Winter	0.962[0.928-0.998]	1.012[0.972-1.053]
Geographical Location		
Coastal Counties	1.051[1.023-1.081]	1.071[1.044-1.099]
Non-Coastal Counties	1.015[0.977-1.055]	1.036[1.017-1.054]

Considerably larger effect observed in coastal counties compared to non-coastal counties

Summary

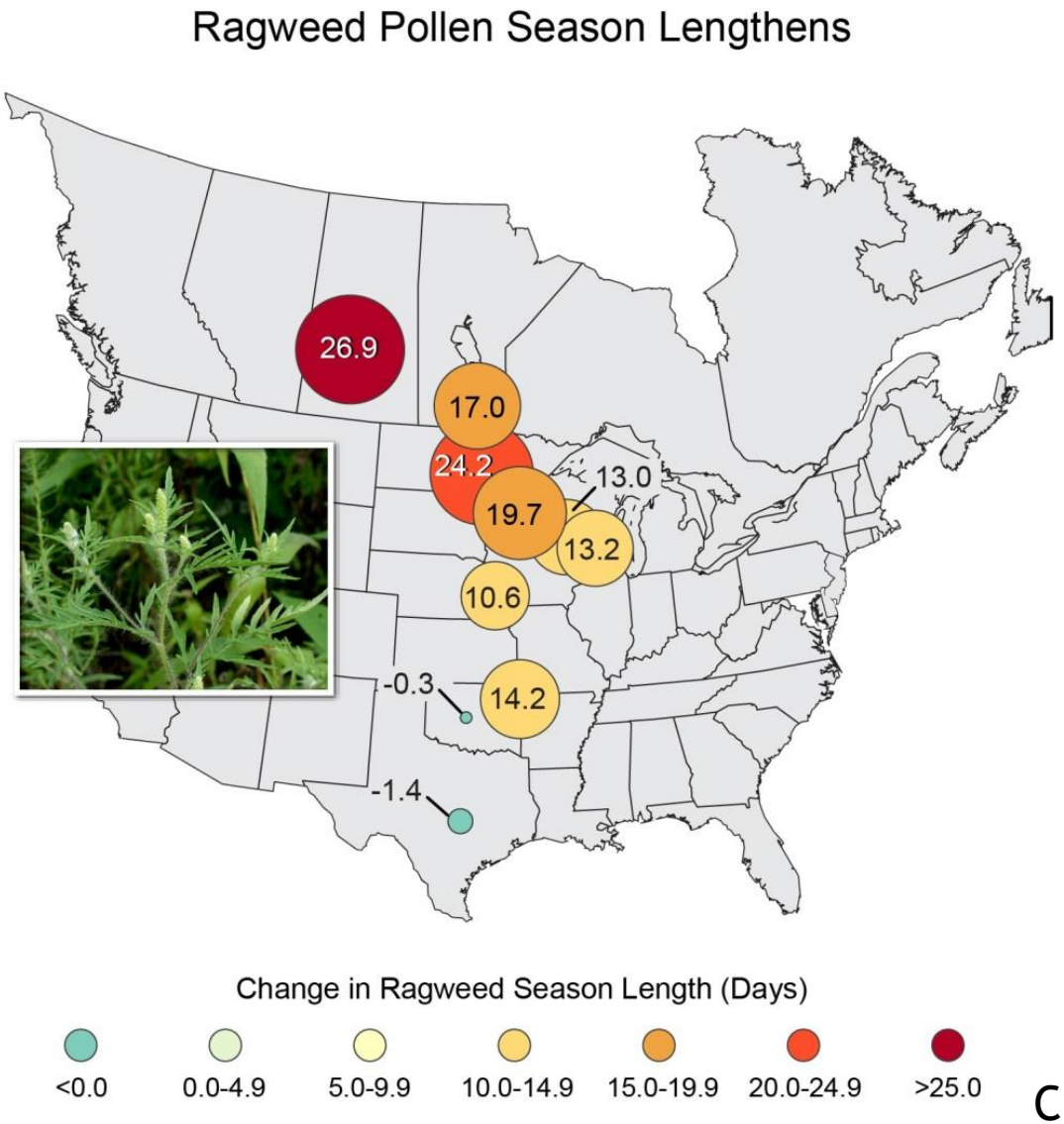
- In Maryland, exposure to extreme heat increases risk of hospitalization for Heart Attack and Asthma.
- Both extreme heat and extreme precipitation increase risk of *Salmonella* infection.
- The risk of *Salmonella* infection is higher in coastal communities.

Climate Change, Alteration in Plant Phenology and Risk of Allergic Rhinitis

Plant Phenology

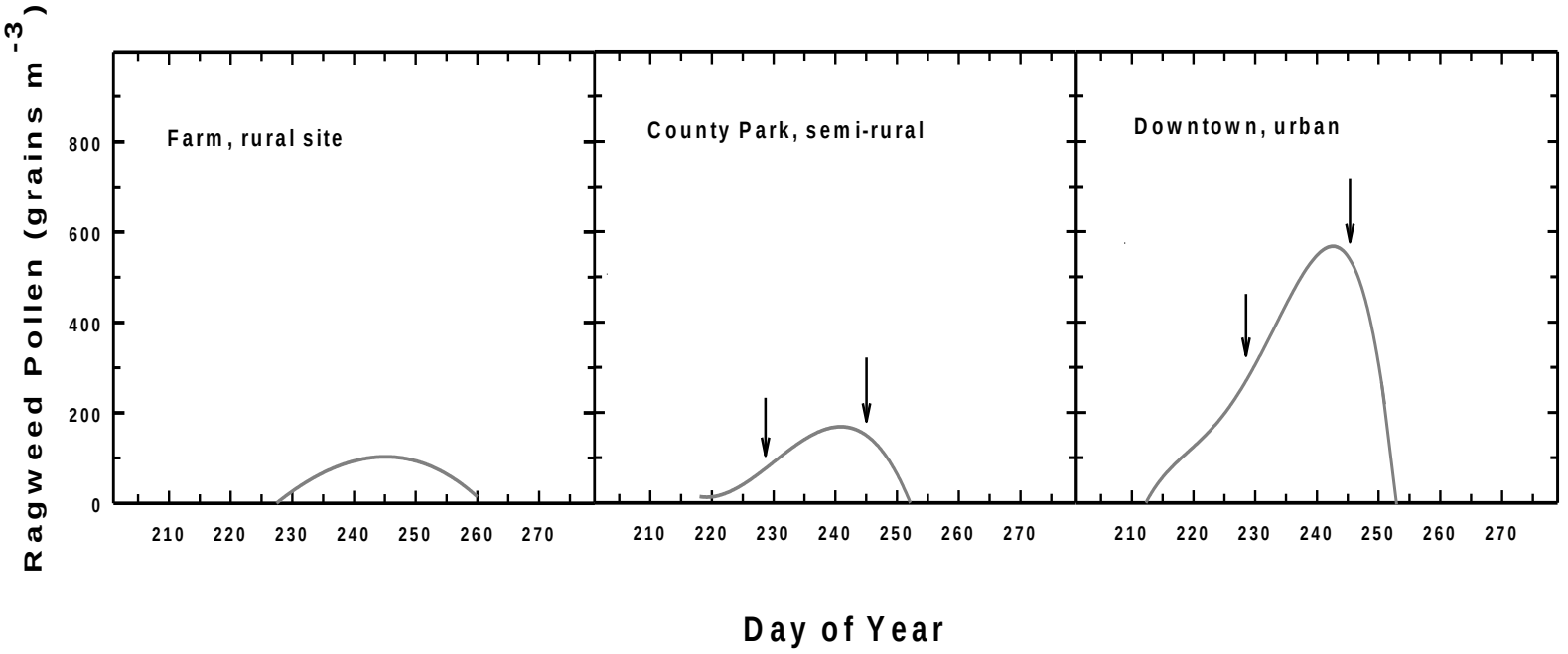
- Nature's calendar
- Timing of seed germination
- Timing of leafing
- Timing of particular flower blooming
- Growing season length
- Most sensitive indicator of ecological response to our changing climate.

Biological Rationale in the Context of Global Climate Change



Credit: Ziska et al. 2011

Ragweed pollen season & concentration: Results from a natural experiment



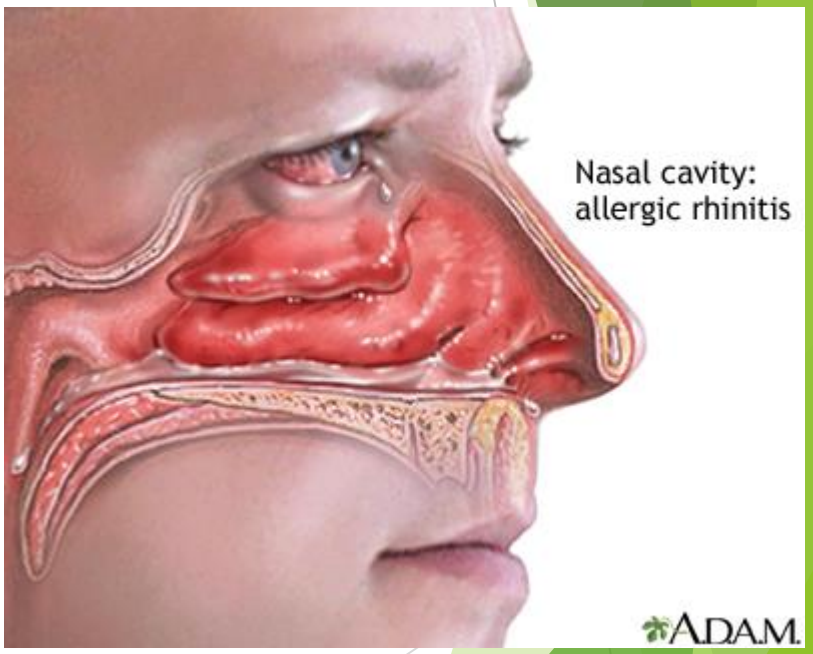
Urban areas:

- Longer growing season, and higher pollen concentration
- Warmer temperatures, and more carbon dioxide.

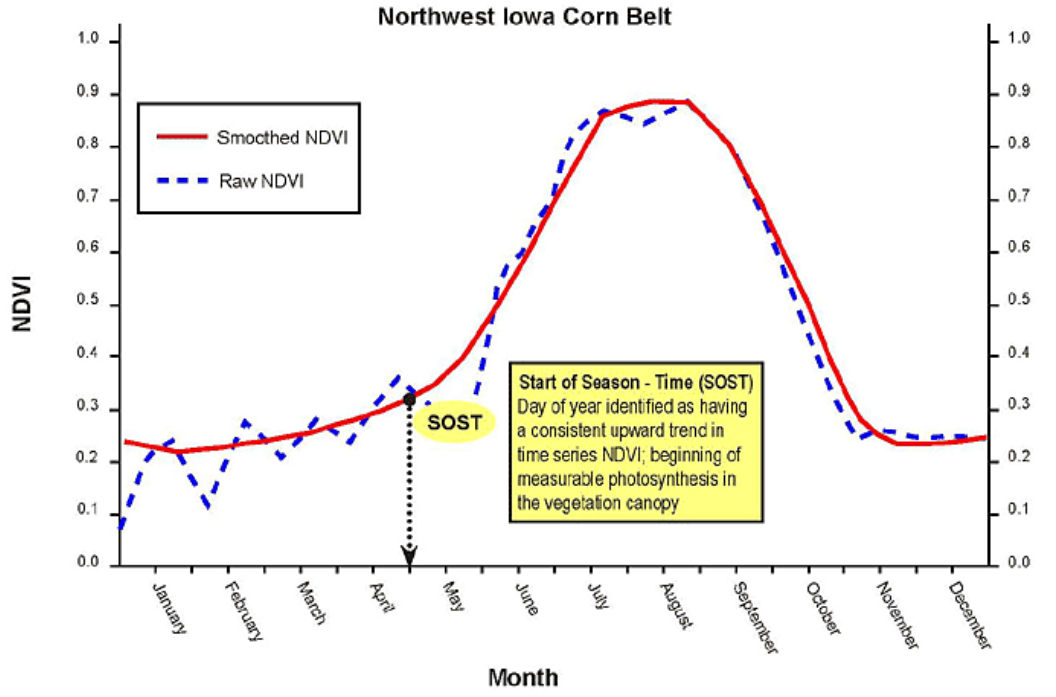
Credit: Dr. Ziska, USDA

Implication to Allergic Disease

- Roughly 8% of US adults suffer from Hay Fever (17.6 million)
- $12 billion every year on medical expenses for hay fever

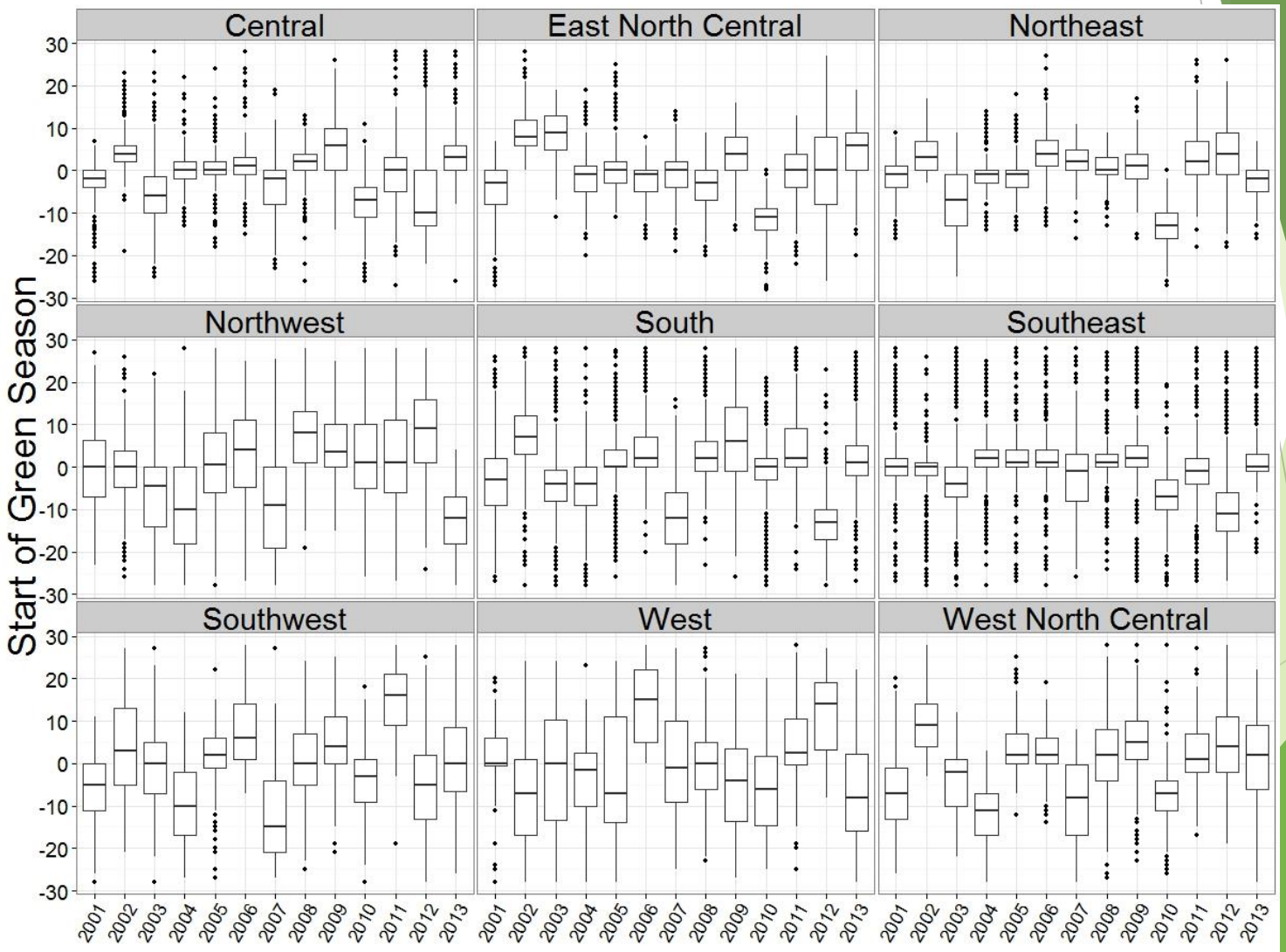


Start of Season (Onset of Greening)



http://phenology.cr.usgs.gov/overview.php
http://phenology.cr.usgs.gov/methods_metrics.php

Temporal Trend in SOS Deviation by Climate Region



Health Data: National Health Interview Survey (NHIS)

- About:
  - Monitored the health of U.S. since 1957
  - Largest and principal source of information on the health of the civilian noninstitutionalized population
- Survey Methodology
  - Cross-sectional household interview survey
  - Samples and interviews continuously throughout each year
  - Sampling plan follows a multistage area probability design that permits the representative sampling of households and noninstitutional group quarters (e.g., college dormitories)

Methodology

- Merge data by county FIPS and year
  - > 0.4 million respondents
    - Deviation in SOS and Hay Fever
  - The county SOS deviations were categorized into five categories of exposure
    - Very Early (more than 3 weeks early)
    - Early (1 to 3 weeks early)
    - Normal (within 1 week: REFERENCE)
    - Late (1 to 3 weeks later)
    - Very Late (more than 3 weeks later).
- Statistical Analysis:
  - Logistic regression using SUDAAN to accounts for the complex clustered sample design of the NHIS

Hay Fever & Phenology: Results

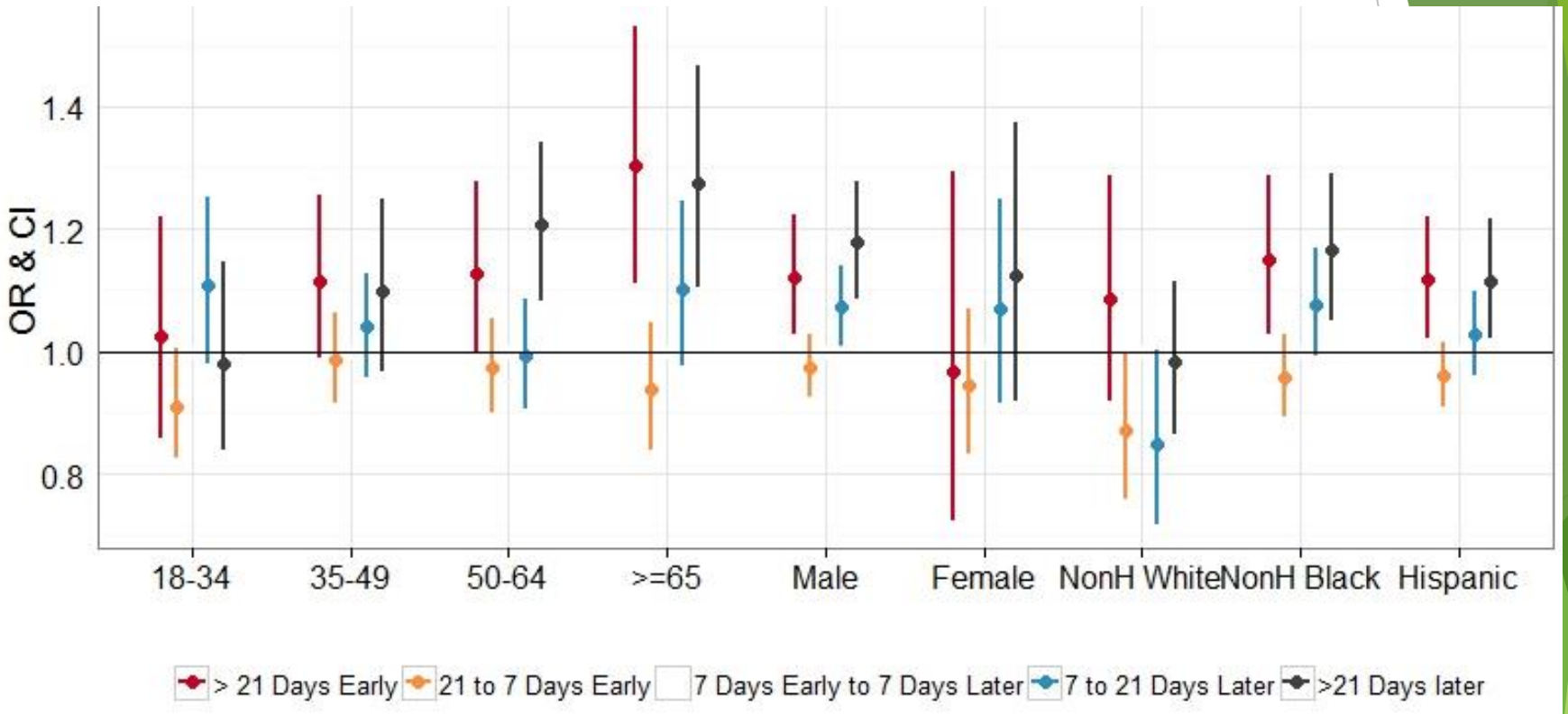
Overall Analysis

Changes in Onset of Greening	Un-Adjusted	Adjusted Model
> 3 Weeks Early	1.08[1.01-1.16]	1.13[1.05-1.22]
1-3 Weeks Early	0.96[0.92-1]	0.96[0.92-1.01]
Within 1 Week	Reference	Reference
1-3 Weeks Later	1.06[1-1.12]	1.05[0.99-1.11]
>3 Weeks later	1.05[0.99-1.12]	1.13[1.06-1.21]

Adjusted for Age, Race, Gender, Education, Insurance, Rural-Urban

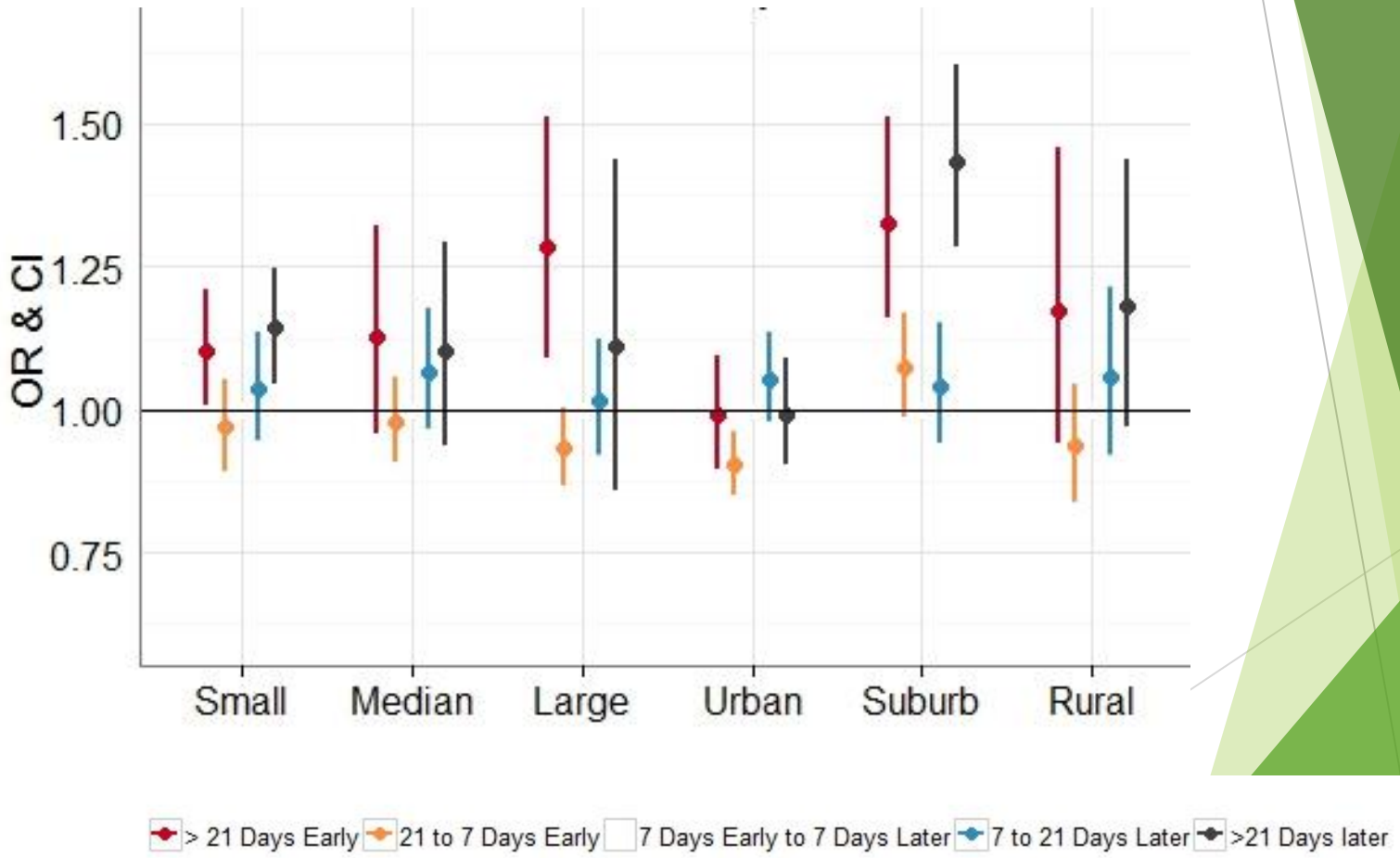
Hay Fever & Phenology: Results

by Demographic Characteristics



Hay Fever & Phenology: Results

by County Size & Urban/Rural Status



Hay Fever & Phenology: Summary

- ***Side note:*** Key determinants of exposure:
  - Frequency of contact to the agent
  - Duration of contact to the agent
  - Concentration of agent in the environment.
- Earlier onset of spring does appears to be a risk factor → Longer Duration of Exposure to pollen?
- Later onset of spring also appears to be a risk factor → More intense exposure within short period of time?

Acknowledgements

No Conflict of Interest

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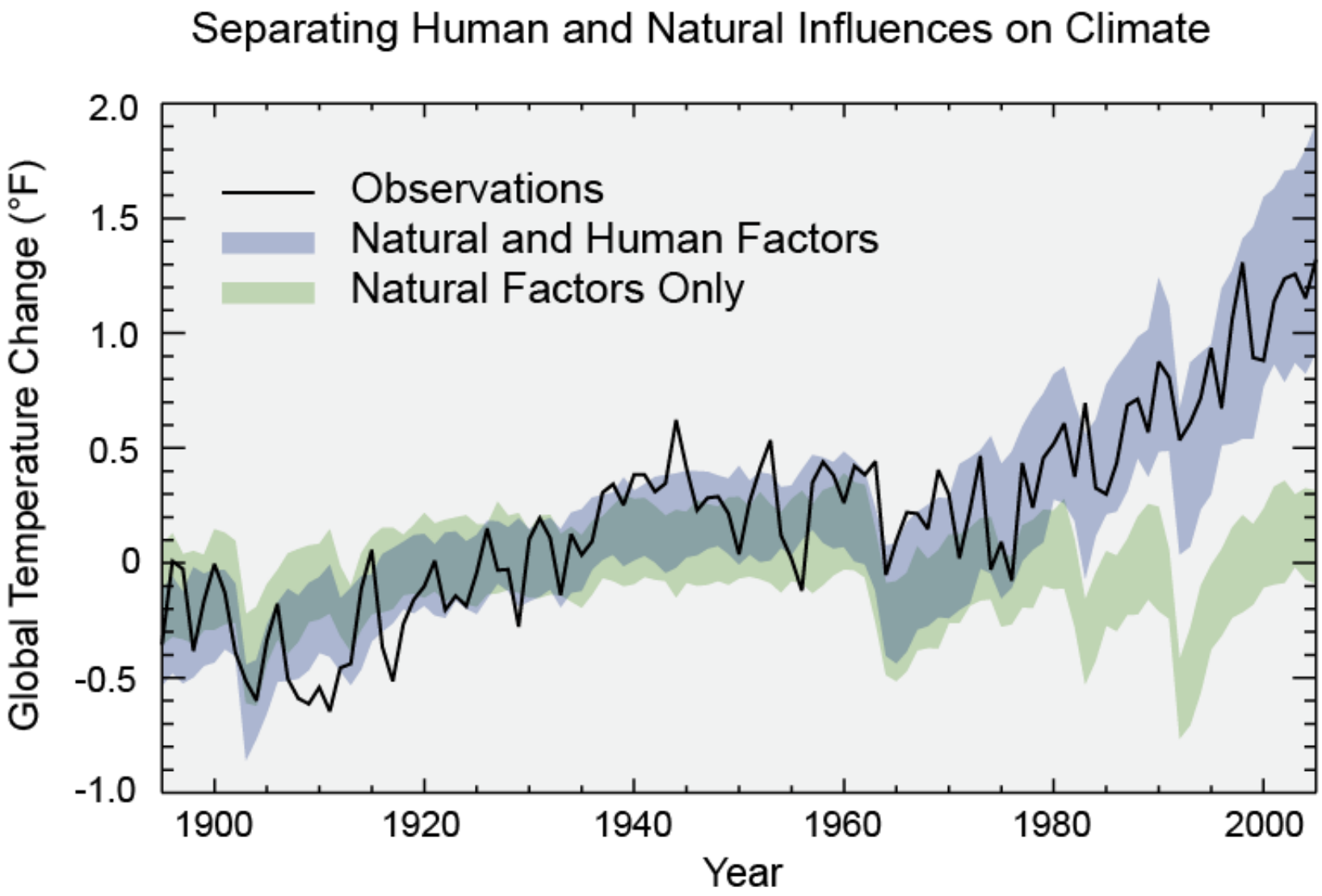
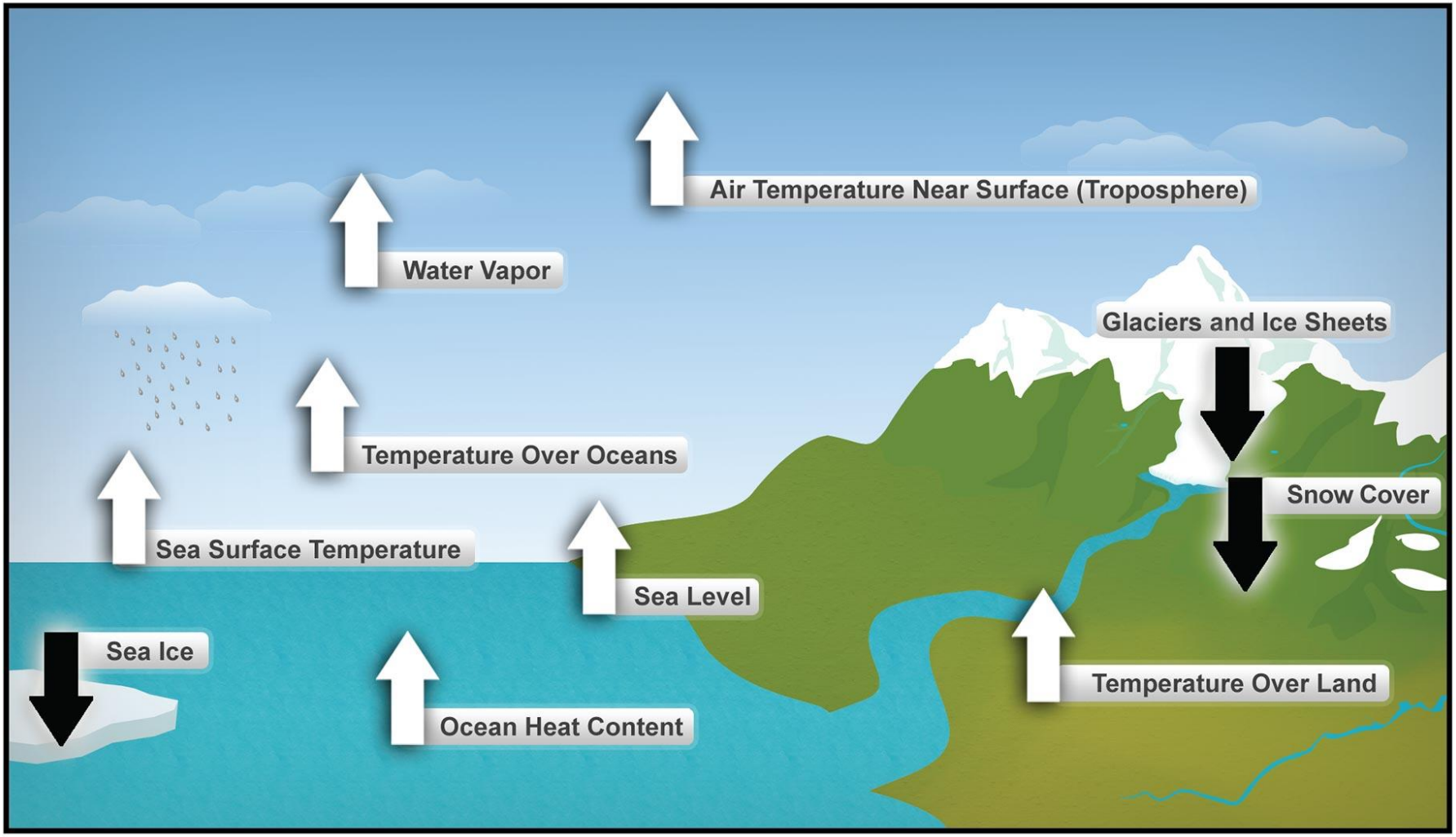
Dr. Sut Soneja, UMD
Dr. Raghu Murtugudde, UMD
Ms. Crystal Romeo-Upperman, UMD
Dr. Xin He, UMD
Mr. Jared Fisher, UMD



National Climate Assessment
http://nca2014.globalchange.gov/

Ten Indicators of a Warming World



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